Atmel SMART Microcontrollers

SAM L22 Xplained Pro

USER GUIDE

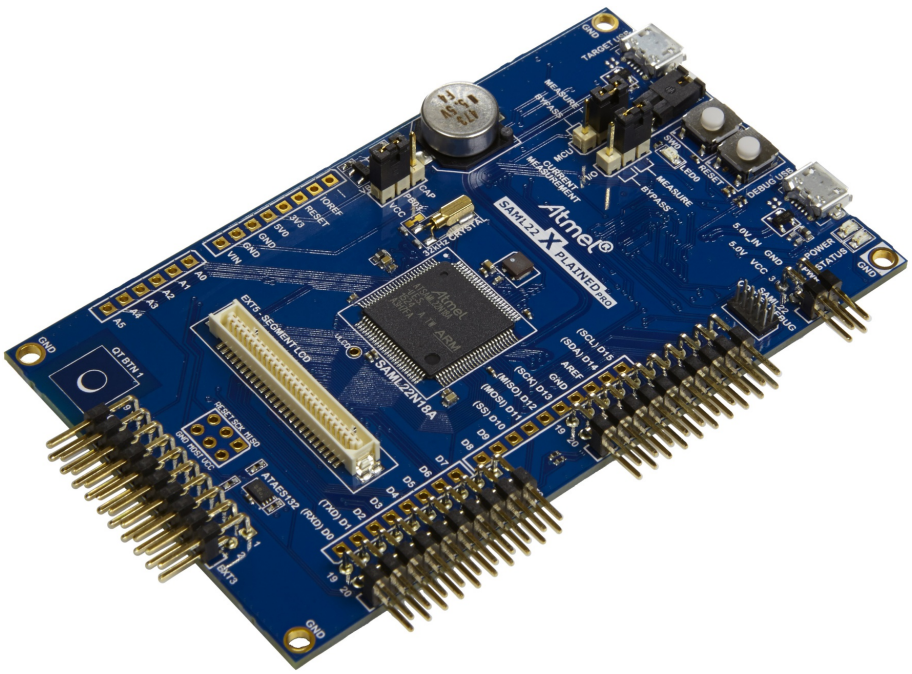
Preface

The Atmel® SAM L22 Xplained Pro evaluation kit is a hardware platform to evaluate the ATSAML22N18A microcontroller.

Supported by the Atmel Studio integrated development platform, the kit provides easy access to the features of the Atmel ATSAML22N18A and explains how to integrate the device in a custom design.

The Xplained Pro MCU series evaluation kits include an on-board Embedded Debugger, and no external tools are necessary to program or debug the ATSAML22N18A.

The Xplained Pro extension kits offers additional peripherals to extend the features of the board and ease the development of custom designs.



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1. Introduction

1.1. Features

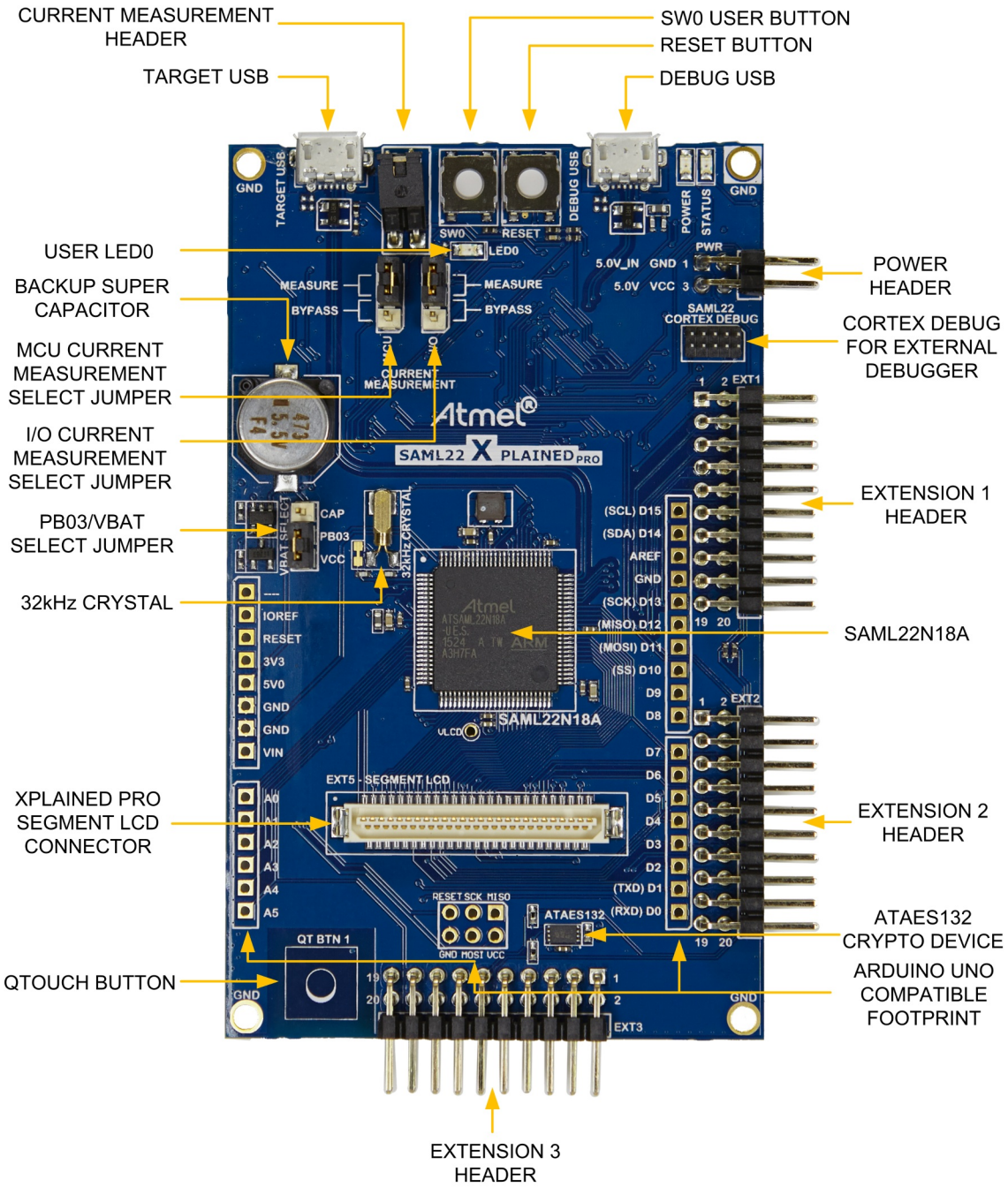
- ATSAML22N18A microcontroller
- One mechanical reset button
- One mechanical programmable button
- Xplained Pro segment LCD connector
  - Eight COM signals
  - Twenty seven SEG signals
  - Six touch signals
- One QTouch® button
- One yellow user LED
- Backup super capacitor
- 32.768kHz crystal
- USB interface, device only
- Three Xplained Pro extension headers
- Embedded Debugger
  - Auto-ID for board identification in Atmel Studio
  - One yellow status LED
  - One green board power LED
  - Symbolic debug of complex data types icluding scope information
  - Programming and debugging, including power measurements
  - Data Gateway Interface: SPI, I^2C, four GPIOs
  - Virtual COM port (CDC)
- Embedded current measurement circuitry, with Atmel Data Visualizer support for data visualization
- USB powered
- Supported with application examples in Atmel Software Framework

1.2. Kit Overview

The Atmel SAM L22 Xplained Pro evaluation kit is a hardware platform to evaluate the Atmel ATSAML22N18A.

The kit offers a set of features that enables the ATSAML22N18A user to get started with the SAM L peripherals right away and to get an understanding of how to integrate the device in their own design.

Figure 1-1 SAM L22 Xplained Pro Evaluation Kit Overview



2. Getting Started

2.1. Xplained Pro Quick Start

Three steps to start exploring the Atmel Xplained Pro platform:

1. Download Atmel Studio.
2. Launch Atmel Studio.
3. Connect a USB cable (Standard-A to Micro-B or Micro-AB) between the PC and the DEBUG USB port on the kit.

When the Atmel SAM L22 Xplained Pro is connected to your computer for the first time, the operating system will perform a driver software installation. The driver file supports both 32- and 64-bit versions of Microsoft® Windows® XP, Windows Vista®, Windows 7, and Windows 8.

Once the Xplained Pro MCU board is powered the green power LED will be lit and Atmel Studio will auto detect which Xplained Pro MCU- and extension board(s) are connected. Atmel Studio will present relevant information like datasheets and kit documentation. The kit landing page in Atmel Studio also has the option to launch Atmel Software Framework (ASF) example applications for the kit. The SAM L22 device is programmed and debugged by the on-board Embedded Debugger and therefore no external programmer or debugger tool is needed.

2.2. Design Documentation and Relevant Links

The following list contains links to the most relevant documents and software for the SAM L22 Xplained Pro.

- **Xplained Pro products** - Atmel Xplained Pro is a series of small-sized and easy-to-use evaluation kits for Atmel microcontrollers and other Atmel products. It consists of a series of low cost MCU boards for evaluation and demonstration of features and capabilities of different MCU families.
- **Atmel Studio** - Free Atmel IDE for development of C/C++ and assembler code for Atmel microcontrollers.
- **Atmel sample store** - Atmel sample store where you can order samples of devices.
- **EDBG User Guide** - User guide containing more information about the on-board Embedded Debugger.
- **IAR Embedded Workbench® for ARM** - This is a commercial C/C++ compiler that is available for ARM. There is a 30 day evaluation version as well as a code size limited kick-start version available from their website. The code size limit is 16KB for devices with M0, M0+, and M1 cores and 32KB for devices with other cores.
- **Atmel QTouch Library** - QTouch Library for Atmel AVR® and ARM® - based microcontrollers.
- **Atmel QTouch Composer** - Tool for developing capacitive buttons, sliders, and wheels applications.
- **Atmel Data Visualizer** - Atmel Data Visualizer is a program used for processing and visualizing data. Data Visualizer can receive data from various sources such as the Embedded Debugger Data Gateway Interface found on Xplained Pro boards, and COM ports.
- **Segment LCD1 Xplained Pro** - Segment LCD1 Xplained Pro is a segment LCD Xplained Pro extension with 96 segments that uses 4 COM and 24 SEG signals. An Xplained Pro MCU board with a Xplained Pro segment LCD connector is required to use the kit.
- **Design Documentation** - Package containing CAD source, schematics, BOM, assembly drawings, 3D plots, layer plots etc.

- **Hardware Users Guide in PDF format** - PDF version of this User Guide.

3. Xplained Pro

Xplained Pro is an evaluation platform that provides the full Atmel microcontroller experience. The platform consists of a series of Microcontroller (MCU) boards and extension boards which are integrated with Atmel Studio, have Atmel Software Framework (ASF) drivers and demo code, support data streaming, and more. Xplained Pro MCU boards support a wide range of Xplained Pro extension boards which are connected through a set of standardized headers and connectors. Each extension board has an identification (ID) chip to uniquely identify which boards are connected to an Xplained Pro MCU board. This information is used to present relevant user guides, application notes, datasheets, and example code through Atmel Studio.

3.1. Embedded Debugger

The SAM L22 Xplained Pro contains the Atmel Embedded Debugger (EDBG) for on-board debugging. The EDBG is a composite USB device of three interfaces; a debugger, Virtual COM Port, and a Data Gateway Interface (DGI).

Together with Atmel Studio, the EDBG debugger interface can program and debug the ATSAML22N18A. On SAM L22 Xplained Pro, the SWD interface is connected between the EDBG and the ATSAML22N18A.

The Virtual COM Port is connected to a UART on the ATSAML22N18A and provides an easy way to communicate with the target application through terminal software. It offers variable baud rate, parity, and stop bit settings. Note that the settings on the ATSAML22N18A must match the settings given in the terminal software.

Note: If not set automatically, data terminal ready (DTR) must be set in the terminal software.

The DGI consists of several physical interfaces for communication with the host computer. Communication over the interfaces is bidirectional. It can be used to send events and values from the ATSAML22N18A or as a generic printf-style data channel. Traffic over the interfaces can be timestamped on the EDBG for more accurate tracing of events. Note that timestamping imposes an overhead that reduces maximal throughput. Atmel Data Visualizer is used to send and receive data through DGI.

The EDBG controls two LEDs on SAM L22 Xplained Pro; a power LED and a status LED. Table 3-1 EDBG LED Control on page 8 shows how the LEDs are controlled in different operation modes.

Table 3-1 EDBG LED Control

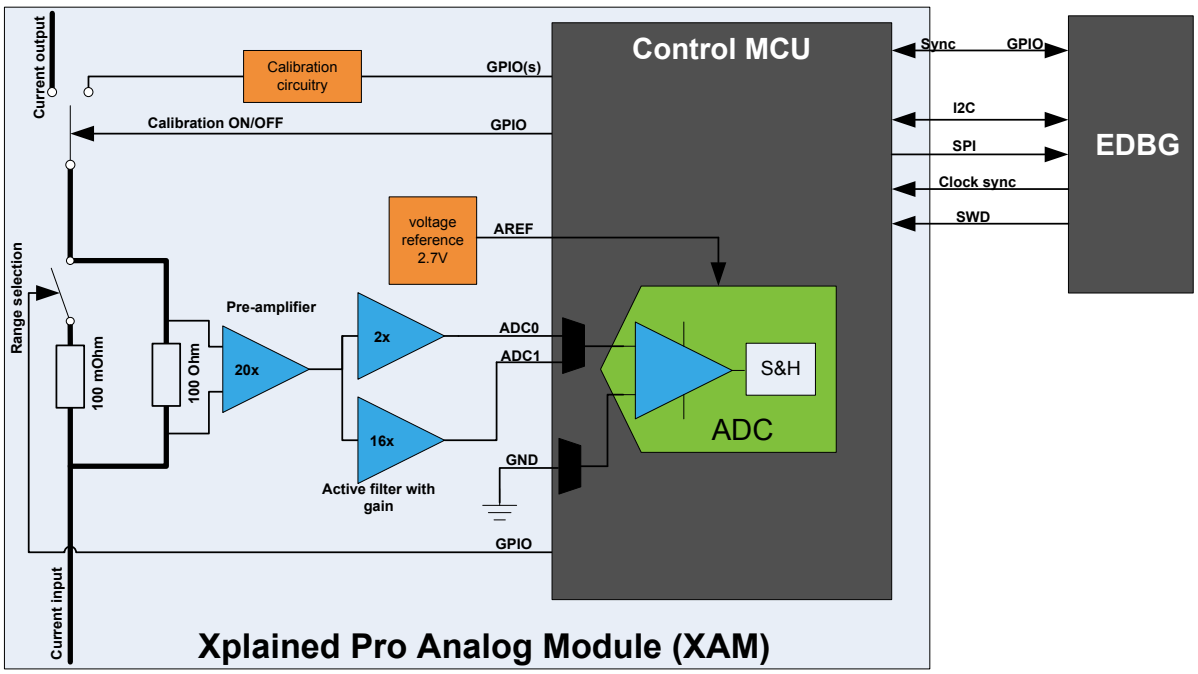
Operation Mode	Power LED	Status LED
Normal operation	Power LED is lit when power is applied to the board.	Activity indicator, LED flashes when any communication happens to the EDBG.
Bootloader mode (idle)	The power LED and the status LED blinks simultaneously.	
Bootloader mode (firmware upgrade)	The power LED and the status LED blinks in an alternating pattern.	

For further documentation on the EDBG, see the EDBG User Guide.

3.2. Xplained Pro Analog Module (XAM)

3.2.1. Overview

The Xplained Pro Analog Module (XAM) extends the embedded debugger with high dynamic range current measurement. This enables power profiling of the target system.



The XAM consists of:

- Calibration circuitry
- Voltage reference
- Analog frontend
  - Shunt resistors with a range selection switch
  - Pre-amplifier
  - Two active filters with gain
- Control MCU
  - Analog to digital converter
  - Signal processing
  - Control/communication interface to the EDBG

The current measurement frontend is a high side shunt measurement with a pre-amplifier and a second active filter stage with gain. The wide dynamic range is achieved by four measurement ranges which are defined by two shunts and the two parallel second stage active filters with gain.

3.2.2. EDBG Interface

The Xplained Pro Analog Module (XAM) is connected to the EDBG with the following interfaces:

- I^2C: This is used to control and configure the XAM
- SPI: Current measurement data is streamed to the EDBG via this interface. This is a one-way data transfer channel from the XAM to the EDBG

- SWD: The MCU in the XAM is programmed via SWD from the EDBG
- GPIO: At least one GPIO that is connected to the EDBG from the target MCU is also connected to the current measurement unit to enable the user to sync current measurements with his application
- Clock sync: Synchronization signal to synchronize ADC measurements with EDBG
- Reference clock: Reference clock for the XAM

3.2.3. Sample Rate

The raw sampling rate of the Xplained Pro analog module (XAM) is up to 250kHz and with the default averaging configuration (average of 16 samples) the actual output of the XAM is 16.67kSPS (note that the XAM output sample rate is not an integer fraction of the raw sampling).

3.2.4. Measurement Ranges and Accuracy

The Xplained Pro analog module has four measurement ranges. These are defined by two shunt resistors and two gain stages.

Measurement range	Hardware	Resolution	Accuracy	Comments
Range 1	Low current shunt and high gain stage	20nA	1 LSB ±1%	Below 1µA the error will increase. Typical error for 300nA is 1 LSB ± 10%
Range 2	Low current shunt and low gain stage	150nA	1 LSB ±1%	
Range 3	High current shunt and high gain stage	10µA	1 LSB ±1%	
Range 4	High current shunt and low gain stage	100µA	1 LSB ±1%	Above 100mA the error will increase to 1 LSB ±5% at 400mA. Maximum current is 400mA

The ranges are switched automatically by the XAM to achieve best measurement results and the currently active range is visualized in the Atmel Data Visualizer frontend tool. The maximum voltage drop over the shunt resistor is 100mV and the XAM will switch the range automatically before this limit is reached.

3.3. Hardware Identification System

All Xplained Pro compatible extension boards have an Atmel ATSHA204 CryptoAuthentication™ chip mounted. This chip contains information that identifies the extension with its name and some extra data. When an Xplained Pro extension is connected to an Xplained Pro MCU board the information is read and sent to Atmel Studio. The Atmel Kits extension, installed with Atmel Studio, will give relevant information, code examples, and links to relevant documents. Table 3-2 Xplained Pro ID Chip Content on page 10 shows the data fields stored in the ID chip with example content.

Table 3-2 Xplained Pro ID Chip Content

Data field	Data type	Example content
Manufacturer	ASCII string	Atmel'\0'
Product Name	ASCII string	Segment LCD1 Xplained Pro'\0'

Data field	Data type	Example content
Product Revision	ASCII string	02'\0'
Product Serial Number	ASCII string	1774020200000010'\0'
Minimum Voltage [mV]	uint16_t	3000
Maximum Voltage [mV]	uint16_t	3600
Maximum Current [mA]	uint16_t	30

3.4. Power Sources

The SAM L22 Xplained Pro kit can be powered by several power sources listed in Table 3-3 Power Sources for SAM L22 Xplained Pro on page 11.

Table 3-3 Power Sources for SAM L22 Xplained Pro

Power input	Voltage requirements	Current requirements	Connector marking
External power	5V ±2% (±100mV) for USB host operation. 4.3V to 5.5V if USB host operation is not required.	Recommended minimum is 1A to be able to provide enough current for connected USB devices and the board itself. Recommended maximum is 2A due to the input protection maximum current specification.	PWR
Embedded debugger USB	4.4V to 5.25V (according to USB spec.)	500mA (according to USB spec.)	DEBUG USB
Target USB	4.4V to 5.25V (according to USB spec.)	500mA (according to USB spec.)	TARGET USB

The kit will automatically detect which power sources are available and choose which one to use according to the following priority:

1. External power.
2. Embedded Debugger USB.
3. Target USB.

Info: External power is required when 500mA from a USB connector is not enough to power the board with possible extension boards. A connected USB device in a USB host application might easily exceed this limit.

3.5. Xplained Pro Headers and Connectors

3.5.1. Xplained Pro Standard Extension Header

All Xplained Pro kits have one or more dual row, 20-pin, 100mil extension header. Xplained Pro MCU boards have male headers, while Xplained Pro extensions have their female counterparts. Note that all pins are not always connected. All connected pins follow the defined pin-out description in Table 3-4 Xplained Pro Standard Extension Header on page 12.

The extension headers can be used to connect a variety of Xplained Pro extensions to Xplained Pro MCU boards or to access the pins of the target MCU on Xplained Pro MCU boards directly.

Table 3-4 Xplained Pro Standard Extension Header

Pin number	Name	Description
1	ID	Communication line to the ID chip on an extension board
2	GND	Ground
3	ADC(+)	Analog to digital converter, alternatively positive part of differential ADC
4	ADC(-)	Analog to digital converter, alternatively negative part of differential ADC
5	GPIO1	General purpose I/O
6	GPIO2	General purpose I/O
7	PWM(+)	Pulse width modulation, alternatively positive part of differential PWM
8	PWM(-)	Pulse width modulation, alternatively negative part of differential PWM
9	IRQ/GPIO	Interrupt request line and/or general purpose I/O
10	SPI_SS_B/ GPIO	Slave select for SPI and/or general purpose I/O
11	I^2C_SDA	Data line for I^2C interface. Always implemented, bus type.
12	I^2C_SCL	Clock line for I^2C interface. Always implemented, bus type.
13	UART_RX	Receiver line of target device UART
14	UART_TX	Transmitter line of target device UART
15	SPI_SS_A	Slave select for SPI. Should preferably be unique.
16	SPI_MOSI	Master out slave in line of serial peripheral interface. Always implemented, bus type.
17	SPI_MISO	Master in slave out line of serial peripheral interface. Always implemented, bus type.
18	SPI_SCK	Clock for serial peripheral interface. Always implemented, bus type.
19	GND	Ground
20	VCC	Power for extension board

3.5.2. Xplained Pro Segment LCD Connector

Xplained Pro MCU boards that have a microcontroller that supports segment LCDs can implement a 51-pin segment LCD extension connector. This connector is implemented with HIROSE DF-9 series. Xplained Pro MCU boards use the male version DF9-51P-1V(69) and Xplained Pro extension boards use the female counterpart DF9-51S-1V(69). The connector has a standardized pin-out as shown in Table 3-5 Xplained Pro Segment LCD Connector on page 13.

Note:
All pins are not connected on all Xplained Pro MCU boards, it depends on how many segments and common terminals the target MCU supports.

Pin 37, 38, 39, 40, 41 and 42 can alternatively be used for QTouch signals. When they are used for touch they should not be used for display segments.

Table 3-5 Xplained Pro Segment LCD Connector

Description	Function	Pin	Pin	Function	Description
Common terminal 3	COM3	1	2	COM2	Common terminal 2
Common terminal 1	COM1	3	4	COM0	Common terminal 0
Segment 0	SEG0	5	6	SEG1	Segment 1
Segment 2	SEG2	7	8	SEG3	Segment 3
Segment 4	SEG4	9	10	SEG5	Segment 5
Segment 6	SEG6	11	12	SEG7	Segment 7
Segment 8	SEG8	13	14	SEG9	Segment 9
Segment 10	SEG10	15	16	SEG11	Segment 11
Segment 12	SEG12	17	18	SEG13	Segment 13
Segment 14	SEG14	19	20	SEG15	Segment 15
Segment 16	SEG16	21	22	SEG17	Segment 17
Segment 18	SEG18	23	24	SEG19	Segment 19
Segment 20	SEG20	25	26	SEG21	Segment 21
Segment 22	SEG22	27	28	SEG23	Segment 23
Segment 24	SEG24	29	30	SEG25	Segment 25
Segment 26	SEG26	31	32	SEG27	Segment 27
Segment 28	SEG28	33	34	SEG29	Segment 29
Segment 30	SEG30	35	36	SEG31	Segment 31
Segment 32 / QTouch X-line 2	SEG32 / QT_X2	37	38	SEG33 / QT_Y2	Segment 33 / QTouch Y-line 2
Segment 34 / QTouch X-line 1	SEG34 / QT_X1	39	40	SEG35 / QT_Y1	Segment 35 / QTouch Y-line 1
Segment 36 / QTouch X-line 0	SEG36 / QT_X0	41	42	SEG37 / QT_Y0	Segment 37 / QTouch Y-line 0

Description	Function	Pin	Pin	Function	Description
Common terminal 4	COM4	43	44	COM5	Common terminal 5
Common terminal 6	COM6	45	46	COM7	Common terminal 6
Backlight anode	Backlight V+	47	48	Backlight V-	Backlight Cathode
Backlight control	Backlight CTRL	49	50	ID	Xplained Pro ID
Ground	GND	51			

3.5.3. Xplained Pro Power Header

The power header can be used to connect external power to the SAM L22 Xplained Pro kit. The kit will automatically detect and switch to any external power if supplied. The power header can also be used as supply for external peripherals or extension boards. Care must be taken not to exceed the total current limitation of the on-board regulator when using the 3.3V pin.

Table 3-6 Xplained Pro Power Header

Pin number	Pin name	Description
1	VEXT_P5V0	External 5V input
2	GND	Ground
3	VCC_P5V0	Unregulated 5V (output, derived from one of the input sources)
4	VCC_P3V3	Regulated 3.3V (output, used as main power supply for the kit)

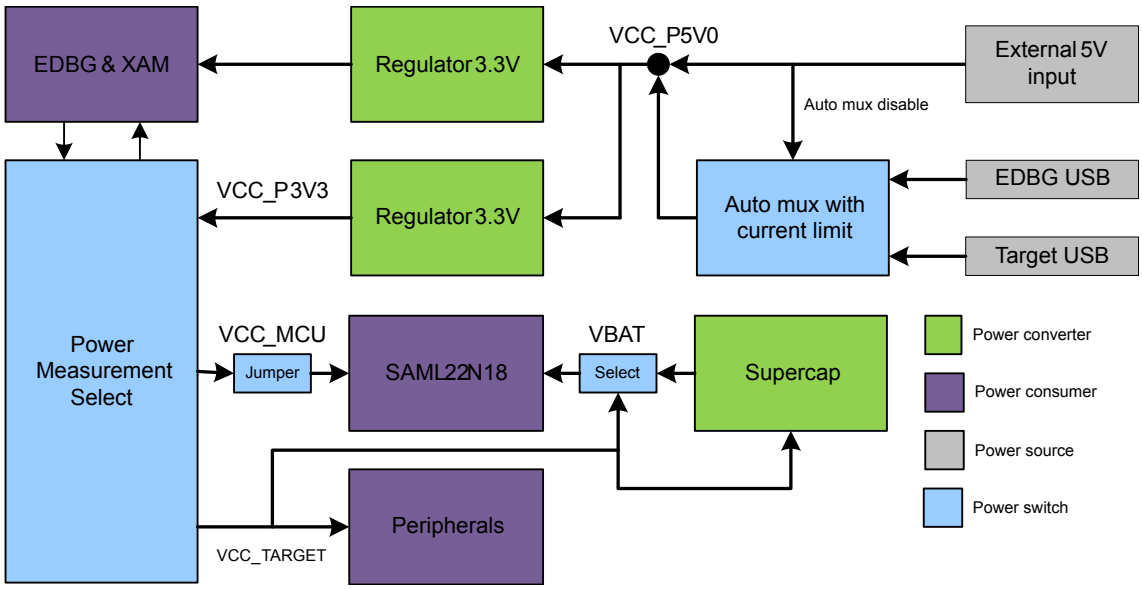
4. Hardware User Guide

4.1. Power Distribution

SAM L22 Xplained Pro has three power sources, EDBG USB, Target USB and/or external 5.0V, the kit will automatically select a source to draw power from. The kit has two on-board 3.3V voltage regulators, one for the EDBG and XAM and one for the ATSAML22N18A and other peripherals.

An on board supercap (47mF) is charged to 3.3V from the target 3.3V net. The supercap is connected to PB03 (VBAT) through a selection header and is intended for backup use in sleep modes.

Figure 4-1 Power Supply Block Diagram



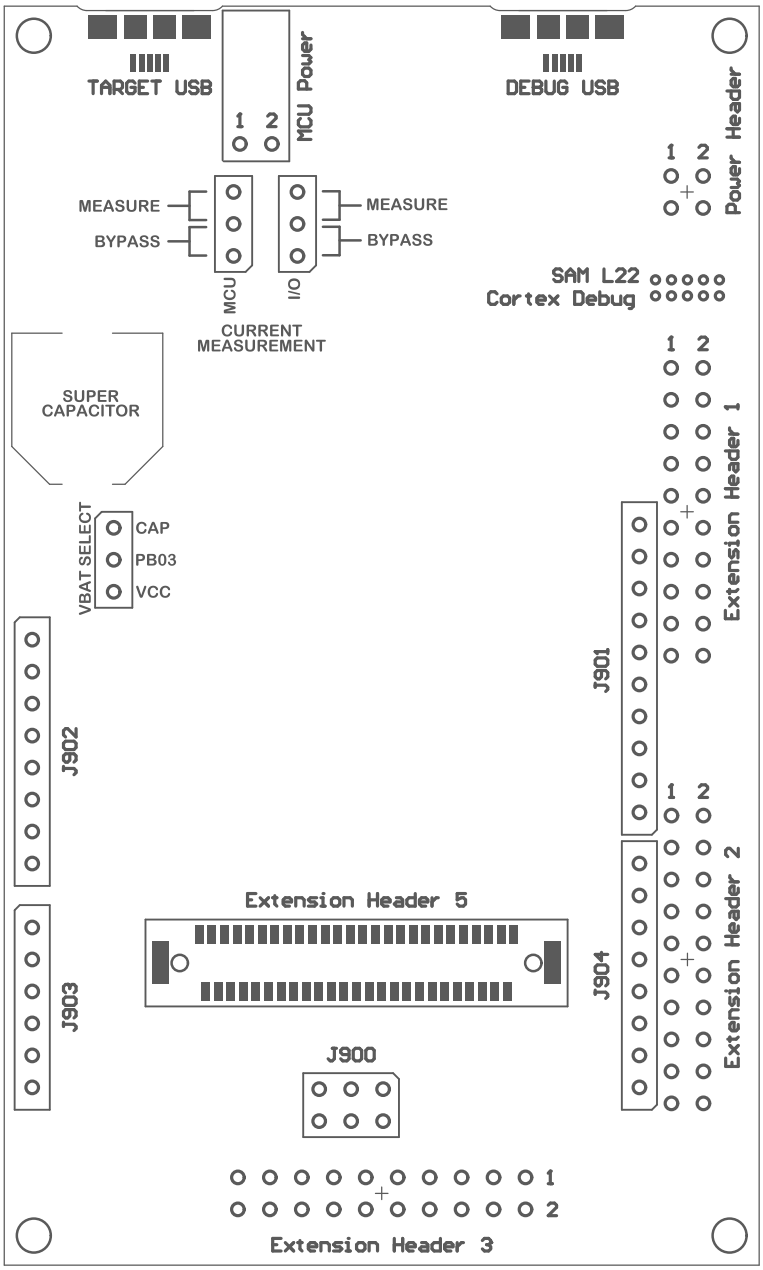
Related Links

Power Sources on page 11

4.2. Connectors

The following sections describes the implementation of the relevant connectors and headers on SAM L22 Xplained Pro and their connection to the ATSAML22N18A. The tables of connections in the sections also describes which signals are shared between the headers and on-board functionality.Figure 4-2 SAM L22 Xplained Pro Connector Overview on page 16 shows all available connectors and jumpers on SAM L22 Xplained Pro.

Figure 4-2 SAM L22 Xplained Pro Connector Overview



4.2.1. Xplained Pro Standard Extension Headers

The SAM L22 Xplained Pro headers EXT1, EXT2, and EXT3 offers access to the I/O of the microcontroller in order to expand the board e.g. by connecting extensions to the board. These headers are based on the standard extension header specified in Table 3-4 Xplained Pro Standard Extension Header on page 12 . The headers have a pitch of 2.54mm.

Table 4-1 Extension Header EXT1

EXT1 pin	SAM L22 pin	Function	Shared functionality
1 [ID]	-	-	Communication line to the ID chip on an extension board.
2 [GND]	-	-	Ground.
3 [ADC(+)]	PA02	AIN[0]	-
4 [ADC(-)]	PA03	AIN[1]	Shield
5 [GPIO1]	PA20	GPIO (RTS)	-
6 [GPIO2]	PA21	GPIO (CTS)	-
7 [PWM(+)]	PB08	TC0/WO[0]	-
8 [PWM(-)]	PB09	TC0/WO[1]	-
9 [IRQ/GPIO]	PC02	IRQ10/GPIO	-
10 [SPI_SS_B/GPIO]	PC03	GPIO	-
11 [TWI_SDA]	PB30	SERCOM5 PAD[0] I²C SDA	EXT2, EXT3, Shield, Crypto, and EDBG I²C
12 [TWI_SCL]	PB31	SERCOM5 PAD[1] I²C SCL	EXT2, EXT3, Shield, Crypto, and EDBG I²C
13 [USART_RX]	PA23	SERCOM2 PAD[1] UART RX	-
14 [USART_TX]	PA22	SERCOM2 PAD[0] UART TX	-
15 [SPI_SS_A]	PB21	SERCOM3 PAD[1] SPI SS	-
16 [SPI_MOSI]	PB00	SERCOM3 PAD[2] SPI MOSI	-
17 [SPI_MISO]	PB02	SERCOM3 PAD[0] SPI MISO	-
18 [SPI_SCK]	PB01	SERCOM3 PAD[3] SPI SCK	-
19 [GND]	-	-	Ground.
20 [VCC]	-	-	Power for extension board.

Table 4-2 Extension Header EXT2

EXT2 pin	SAM L22 pin	Function	Shared functionality
1 [ID]	-	-	Communication line to the ID chip on an extension board.
2 [GND]	-	-	Ground.
3 [ADC(+)]	PA04	AIN[4]	Shield
4 [ADC(-)]	PA05	AIN[5]	Shield
5 [GPIO1]	PB04	GPIO	EDBG GPIO0 and SLCD

EXT2 pin	SAM L22 pin	Function	Shared functionality
6 [GPIO2]	PB05	GPIO	EDBG GPIO1 and SLCD
7 [PWM(+)]	PC28	TCC0/WO[4]	SLCD
8 [PWM(-)]	PA27	TCC0/WO[5]	SLCD
9 [IRQ/GPIO]	PB06	IRQ6/GPIO	Shield and EDBG GPIO2
10 [SPI_SS_B/GPIO]	PB07	GPIO	Shield and EDBG GPIO3
11 [TWI_SDA]	PB30	SERCOM5 PAD[0] I²C SDA	EXT1, EXT3, Shield, Crypto, and EDBG I²C
12 [TWI_SCL]	PB31	SERCOM5 PAD[1] I²C SCL	EXT1, EXT3, Shield, Crypto, and EDBG I²C
13 [USART_RX]	PA13	SERCOM3 PAD[1] UART RX	-
14 [USART_TX]	PA12	SERCOM3 PAD[0] UART TX	-
15 [SPI_SS_A]	PA17	SERCOM1 PAD[1] SPI SS	-
16 [SPI_MOSI]	PA18	SERCOM1 PAD[2] SPI MOSI	-
17 [SPI_MISO]	PA16	SERCOM1 PAD[0] SPI MISO	-
18 [SPI_SCK]	PA19	SERCOM1 PAD[3] SPI SCK	-
19 [GND]	-	-	Ground.
20 [VCC]	-	-	Power for extension board.

Table 4-3 Extension Header EXT3

EXT3 pin	SAM L22 pin	Function	Shared functionality
1 [ID]	-	-	Communication line to the ID chip on an extension board.
2 [GND]	-	-	Ground.
3 [ADC(+)]	PA06	AIN[8]	SLCD
4 [ADC(-)]	PA07	AIN[9]	SLCD
5 [GPIO1]	PC16	GPIO	SLCD
6 [GPIO2]	PC17	GPIO	SLCD
7 [PWM(+)]	PB16	TC2/WO[0]	SLCD
8 [PWM(-)]	PB17	TC2/WO[1]	SLCD
9 [IRQ/GPIO]	PB18	IRQ2/GPIO	SLCD
10 [SPI_SS_B/GPIO]	PB19	GPIO	SLCD
11 [TWI_SDA]	PB30	SERCOM5 PAD[0] I²C SDA	EXT1, EXT2, Shield, Crypto, and EDBG I²C

EXT3 pin	SAM L22 pin	Function	Shared functionality
12 [TWI_SCL]	PB31	SERCOM5 PAD[1] I²C SCL	EXT1, EXT2, Shield, Crypto, and EDBG I²C
13 [USART_RX]	PA15	SERCOM4 PAD[3] UART RX	SLCD
14 [USART_TX]	PA14	SERCOM4 PAD[2] UART TX	SLCD
15 [SPI_SS_A]	PA09	SERCOM0 PAD[1] SPI SS	SLCD
16 [SPI_MOSI]	PA10	SERCOM0 PAD[2] SPI MOSI	SLCD
17 [SPI_MISO]	PA08	SERCOM0 PAD[0] SPI MISO	SLCD
18 [SPI_SCK]	PA11	SERCOM0 PAD[3] SPI SCK	SLCD
19 [GND]	-	-	Ground.
20 [VCC]	-	-	Power for extension board.

4.2.2. Segment LCD Connector

Extension connector EXT5 is a special connector for segment LCD displays. SAM L22 Xplained Pro implements one segment LCD extension connector for Xplained Pro extensions and supports up to eight COM, twenty seven SEG and six touch signals. The connector has a standardized pin-out as shown in Table 3-5 Xplained Pro Segment LCD Connector on page 13.

Table 4-4 Segment LCD Display Connector EXT5

EXT5 Pin	SAM L22 pin	Function	Shared functionality
1 [COM3]	PC06	SLCD/ LP[9]	Shield
2 [COM2]	PC05	SLCD/ LP[8]	Shield
3 [COM1]	PA07	SLCD/ LP[7]	Shield and EXT3
4 [COM0]	PA06	SLCD/ LP[6]	Shield and EXT3
5 [SEG0]	PA11	SLCD/ LP[14]	EXT3
6 [SEG1]	PC08	SLCD/ LP[15]	
7 [SEG2]	PC09	SLCD/ LP[16]	
8 [SEG3]	PC10	SLCD/ LP[17]	
9 [SEG4]	PC11	SLCD/ LP[18]	Shield and Shield (2)
10 [SEG5]	PC12	SLCD/ LP[19]	Shield and Shield (2)
11 [SEG6]	PC13	SLCD/ LP[20]	Shield and Shield (2)
12 [SEG7]	PB11	SLCD/ LP[21]	Shield
13 [SEG8]	PB12	SLCD/ LP[22]	Shield
14 [SEG9]	PB13	SLCD/ LP[23]	Shield
15 [SEG10]	PB14	SLCD/ LP[24]	Shield
16 [SEG11]	PB15	SLCD/ LP[25]	Shield

EXT5 Pin	SAM L22 pin	Function	Shared functionality
17 [SEG12]	PC14	SLCD/ LP[26]	Shield
18 [SEG13]	PC15	SLCD/ LP[27]	Shield
19 [SEG14]	PA14	SLCD/ LP[30]	EXT3
20 [SEG15]	PA15	SLCD/ LP[31]	EXT3
21 [SEG16]	PC16	SLCD/ LP[36]	EXT3
22 [SEG17]	PC17	SLCD/ LP[37]	EXT3
23 [SEG18]	PC18	SLCD/ LP[38]	
24 [SEG19]	PC19	SLCD/ LP[39]	
25 [SEG20]	PC20	SLCD/ LP[40]	
26 [SEG21]	PC21	SLCD/ LP[41]	Crypto
27 [SEG22]	PB16	SLCD/ LP[42]	EXT3
28 [SEG23]	PB17	SLCD/ LP[43]	EXT3
29 [SEG24]	PB18	SLCD/ LP[44]	EXT3
30 [SEG25]	PB19	SLCD/ LP[45]	EXT3
31 [SEG26]	PB20	SLCD/ LP[46]	Shield
32 [SEG27]	-		
33 [SEG28]	-		
34 [SEG29]	-		
35 [SEG30]	-		
36 [SEG31]	-		
37 [SEG32/ QT_X2]	PC01	PTC/X[5]	User SW0
38 [SEG33/ QT_Y2]	PB05	PTC/X[11]	EDBG GPIO1 and EXT2
39 [SEG34/ QT_X1]	PC00	PTC/X[4]	QTBTN1
40 [SEG35/ QT_Y1]	PB04	PTC/Y[10]	EDBG GPIO0 and EXT2
41 [SEG36/ QT_X0]	PC28	PTC/X[20]	EXT2
42 [SEG37/ QT_Y0]	PA27	PTC/Y[21]	EXT2
43 [COM4]	PC07	SLCD/ LP[10]	Shield
44 [COM5]	PA08	SLCD/ LP[11]	EXT3
45 [COM6]	PA09	SLCD/ LP[12]	EXT3

EXT5 Pin	SAM L22 pin	Function	Shared functionality
46 [COM7]	PA10	SLCD/ LP[13]	EXT3
47 [Backlight V+]	-	VCC_P3V3	
48 [Backlight V-]	-	GND	
49 [Backlight CTRL]	PC27	TC3/WO[1]	User LED0
50 [ID]	-	Xplained Pro ID	Communication line to ID chip on extension board.
51 [GND]	-	GND	

4.2.3. Arduino Connector Footprint

SAM L22 Xplained Pro implements Arduino shield connectors footprints based on the Arduino Uno. All references to Arduino pin names are taken from the official Arduino schematics of the Arduino Uno.

Info: Note that all pins do not have the exact same functionality as on the Arduino Uno on the shield connectors, each shield should be checked for compatibility before it is connected.

Table 4-5 J902 - Power

Pin on J902	SAM L22 pin	Arduino pin name	Function	Shared functionality
1	-	RFU	-	-
2	-	IOREF	VCC_TARGET_P3V3	-
3	RESETN	RESET	TARGET_RESET	-
4	-	3.3V	VCC_TARGET_P3V3	-
5	-	5V	VCC_P5V0	-
6	-	GND	GND	-
7	-	GND	GND	-
8	-	VIN	VCC_EXT_P5V0	-

Table 4-6 J903 - Analog

Pin on J903	SAM L22 pin	Arduino pin name	Function	Shared functionality
1	PB06	ADC0	AIN14	EXT2 and EDBG GPIO2
2	PB07	ADC1	AIN15	EXT2 and EDBG GPIO3

Pin on J903	SAM L22 pin	Arduino pin name	Function	Shared functionality
3	PA04	ADC2	AIN4	EXT2
4	PA05	ADC3	AIN5	EXT2
5	PA06	ADC4	AIN6	EXT3 and SLCD
6	PA07	ADC5	AIN7	EXT3 and SLCD

Table 4-7 J904 - Digital Low

Pin on J904	SAM L22 pin	Arduino pin name	Function	Shared functionality
1	PB13	D0 / RX0	SERCOM3 PAD[1] UART RX	SLCD
2	PB12	D1 / TX0	SERCOM3 PAD[0] UART TX	SLCD
3	PB11	D2	GPIO	SLCD
4	PB14	D3	GPIO	SLCD
5	PB15	D4	GPIO	SLCD
6	PC14	D5	GPIO	SLCD
7	PC15	D6	GPIO	SLCD
8	PB20	D7	GPIO	SLCD

Table 4-8 J901 - Digital High

Pin on J901	SAM L22 pin	Arduino pin name	Function	Shared functionality
1	PC05	D8	GPIO	SLCD
2	PC06	D9	GPIO	SLCD
3	PC07	D10 / SPI-SS	GPIO	SLCD
4	PC12	D11 / SPI-MOSI	SERCOM1 PAD[0] SPI MOSI	SLCD and Shield
5	PC11	D12 / SPI-MISO	SERCOM1 PAD[3] SPI MISO	SLCD and Shield
6	PC13	D13 / SPI-SCK	SERCOM1 PAD[1] SPI SCK	SLCD and Shield
7	-	GND	-	-
8	PA03	AREF	ADC / DAC VREFA	EXT1

Pin on J901	SAM L22 pin	Arduino pin name	Function	Shared functionality
9	PB30	SDA	SERCOM5 PAD[0] I²C SDA	EXT1, EXT2, EXT3, Crypto, and EDBG I²C
10	PB31	SCL	SERCOM5 PAD[1] I²C SCL	EXT1, EXT2, EXT3, Crypto, and EDBG I²C

Table 4-9 J900 - SPI

Pin on J900	SAM L22 pin	Arduino pin name	Function	Shared functionality
1	PC11	MISO	SERCOM1 PAD[3] SPI MISO	SLCD and Shield
2	-	**5V**	VCC_P5V0	-
3	PC13	SCK	SERCOM1 PAD[1] SPI SCK	SLCD and Shield
4	PC12	MOSI	SERCOM1 PAD[0] SPI MOSI	SLCD and Shield
5	RESETN	RESET	TARGET_RESET	-
6	-	GND	GND	-

4.2.4. USB

The SAM L22 Xplained Pro has a Micro-USB connector for use with the SAM L22 USB module labeled as TARGET USB on the kit. To be able to detect when a target USB cable is connected in self-powered mode, a GPIO is used to detect the VBUS voltage on the connector.

Table 4-10 USB Connections

SAM L22 pin	USB function
PC26	VBUS Detection
PA24	USB D-
PA25	USB D+

4.2.5. Current Measurement Header

An angled 1x2, 100mil pin-header marked with MCU current measurement is located at the upper edge of the SAM L22 Xplained Pro. All power to the ATSAML22N18A is routed through this header. To measure the power consumption of the device remove the jumper and replace it with an ammeter.

Caution: Removing the jumper from the pin-header while the kit is powered may cause the ATSAML22N18A to be powered through its I/O pins. This may cause permanent damage to the device.

4.2.6. Cortex Debug Connector

SAM L22 Xplained Pro has a 10-pin 50-mil Cortex® Debug Connector that can be used to attach external debuggers to the ATSAML22N18A.

Table 4-11 Cortex Debug Connector

Cortex Debug Connector pin	Pin / Net	Function	Shared functionality
1	VCC_TARGET_P3V3	ATSAML22N18A voltage	
2	PA31	SWD data signal	EDBG SWD
3	GND	Ground	
4	PA30	SWD clock signal	EDBG SWD
5	GND	Ground	
6	-	-	
7	-	-	
8	-	-	
9	GND	Ground	
10	RESETN	Target reset signal	

4.3. Peripherals

4.3.1. Crystal

The SAM L22 Xplained Pro kit contains a 32.768kHz crystal that can be used as clock source for the SAM L22 device. The crystal has a cut-strap next to it that can be used to measure the oscillator safety factor. This is done by cutting the strap and adding a resistor across the strap. More information about oscillator allowance and safety factor can be found in appnote AVR41001.

Table 4-12 External 32.768kHz Crystal

SAM L22 pin	Function
PA00	XIN32
PA01	XOUT32

4.3.2. Mechanical Buttons

SAM L22 Xplained Pro contains two mechanical buttons. One button is the RESET button connected to the SAM L22 reset line and the other is a generic user configurable button. When a button is pressed it will drive the I/O line to GND.

Info: There is no pull-up resistor connected to the generic user button. Remember to enable the internal pull-up in the SAM L22 to use the button.

Table 4-13 Mechanical Buttons

SAM L22 pin	Silkscreen text	Shared functionality
RESET	RESET	
PC01	SW0	SLCD

4.3.3. LED

There is one yellow LED available on the SAM L22 Xplained Pro board that can be turned on and off. The LED can be activated by driving the connected I/O line to GND.

Table 4-14 LED Connection

SAM L22 pin	Function	Shared functionality
PC27	Yellow LED0	SLCD

4.3.4. QTouch Button

There is one self capacitance button available on the SAM L22 Xplained Pro board that can be used as I/O. This QTouch button is intended to be driven by the built-in Peripheral Touch Controller (PTC) of the device.

Info: To get started with QTouch refer to Atmel QTouch Library and Atmel QTouch Composer.

Table 4-15 QTouch Connection

SAM L22 pin	Silkscreen text	Shared functionality
PC00	QT BTN1	SLCD

4.3.5. Backup Supercap

The SAM L22 Xplained Pro has a backup super capacitor for use with the SAM L22 backup module. The supercap can be connected to the device by placing a jumper over pin 1-2 on the 3-pin VBAT SELECT header.

By default the jumper is placed over pin 2-3 to select the board power supply. This configuration is selected to avoid draining the supercap and can be used during development.

Due to the high capacitive load represented by the supercap, a 220Ω limiting resistor is added to reduce inrush current. The charging supply is the targets main supply and a low-power opamp is is used for disconnecting the charger input when removing power. This is added to avoid a current leak back to the main supply from the supercap when power is removed.

A full charge of the supercap from empty will take approximately 45 seconds and can supply the target device in backup mode with ULP running for up to 24 hours. Other modes are not characherized, but will reduce the available time in backup mode respectively. For more information about the current consumption in other modes, refer to the electrical characteristics chapter in the SAM L22 datasheet.

Table 4-16 VBAT SELECT Header

VBAT SELECT pin	Function
1	Power from super capacitor (47mF)
2	PB03/VBAT pin on SAM L22
3	Power from board supply

4.3.6. Crypto Device

Several of the Atmel security devices requires only an I²C interface to work, and they share the same packages and pinouts. SAM L22 Xplained Pro implements a DFN8 footprint for these devices so the user may test the mounted ATAES132A device or solder in other CryptoAuthentication devices. Table 4-17 Crypto Device Connections on page 26 shows all the connections between the ATAES132A and the ATSAML22N18A.

Table 4-17 Crypto Device Connections

ATAES132A pin	SAM L22 pin	Function	Shared functionality
1 [NC]	-	GND	-
2 [AUTHO]	PC21	GPIO/EIC	SLCD
3 [NC]	-		-
4 [GND]	-	GND	-
5 [SDA]	PB30	SERCOM5 PAD[0] I²C SDA	EXT1, EXT2, EXT3, Shield, and EDBG I²C
6 [SCL]	PB31	SERCOM5 PAD[1] I²C SCL	EXT1, EXT2, EXT3, Shield, and EDBG I²C
7 [NC]	-		-
8 [VCC]	-	VCC_TARGET_P3V3	-
PAD	-	GND	-

4.3.7. Tamper Detection

The ATSAML22N18A supports up to five selectable polarity external inputs and one output that can be used for tamper detection. When tamper is detected a time stamp is logged and an interrupt is raised. The output pin can be used for PCB active layer detection, when enabled a bit pattern is applied to the output pin, if this pattern is not detected at an input pin a tamper is detected.

PC01, one of the inputs, is connected to the on-board user button. PB01, the tamper output, is connected to EXT1 together with several tamper inputs. Pressing the user button or using a jumper on EXT1 between PB01 and an input can emulate for example the chassis of a product being opened or a modification to a PCB.

For more details about how the tamper functionality works see the SAM L22 data sheet.

Table 4-18 Tamper Detection

SAM L22 pin	Tamper name	Shared functionality
PC00	IN[3]	SLCD and QTBTN1
PC01	IN[4]	SLCD and User SW0
PA02	IN[2]	EXT1 pin 3
PB00	IN[0]	EXT1 pin 16
PB01	OUT	EXT1 pin 18
PB02	IN[1]	EXT1 pin 17

4.4. Embedded Debugger Implementation

SAM L22 Xplained Pro contains an Embedded Debugger (EDBG) that can be used to program and debug the ATSAML22N18A using Serial Wire Debug (SWD). The Embedded Debugger also include a Virtual Com port interface over UART, an Atmel Data Gateway Interface over SPI, and TWI and it includes four of the SAM L22 GPIOs. Atmel Studio can be used as a front end for the Embedded Debugger.

4.4.1. Serial Wire Debug

The Serial Wire Debug (SWD) use two pins to communicate with the target. For further information on how to use the programming and debugging capabilities of the EDBG, see Embedded Debugger on page 8.

Table 4-19 SWD Connections

SAM L22 pin	Function	Shared functionality
PA30	SWD clock	Cortex Debug
PA31	SWD data	Cortex Debug

4.4.2. Virtual COM Port

The Embedded Debugger acts as a Virtual Com Port gateway by using one of the ATSAML22N18A UARTs. For further information on how to use the Virtual COM port, see Embedded Debugger on page 8.

Table 4-20 Virtual COM Port Connections

SAM L22 pin	Function	Shared functionality
PC24	SERCOM4 PAD[2] UART TXD (SAM L22 TX line)	-
PC25	SERCOM4 PAD[3] UART RXD (SAM L22 RX line)	-

4.4.3. Atmel Data Gateway Interface

The Embedded Debugger features an Atmel Data Gateway Interface (DGI) by using either a SPI or I²C. The DGI can be used to send a variety of data from the ATSAML22N18A to the host PC. For further information on how to use the DGI interface, see Atmel Data Visualizer and the EDBG User Guide.

Table 4-21 DGI Interface Connections when using SPI

SAM L22 pin	Function	Shared functionality
PB25	SERCOM5 PAD[1] SPI SS (Slave select) (SAM L22 is Master)	-
PB24	SERCOM5 PAD[0] SPI MISO (Master In, Slave Out)	-
PB22	SERCOM5 PAD[2] SPI MOSI (Master Out, Slave in)	-
PB23	SERCOM5 PAD[3] SPI SCK (Clock Out)	-

Table 4-22 DGI Interface Connections when using I²C

SAM L22 pin	Function	Shared functionality
PB30	SERCOM5 PAD[0] SDA (Data line)	EXT1, EXT2, EXT3, Shield, and Crypto
PB31	SERCOM5 PAD[1] SCL (Clock line)	EXT1, EXT2, EXT3, Shield, and Crypto

Four GPIO lines are connected to the Embedded Debugger. The EDBG can monitor these lines and time stamp pin value changes. This makes it possible to accurately time stamp events in the SAM L22 application code. For further information on how to configure and use the GPIO monitoring features, see Atmel Data Visualizer and the EDBG User Guide.

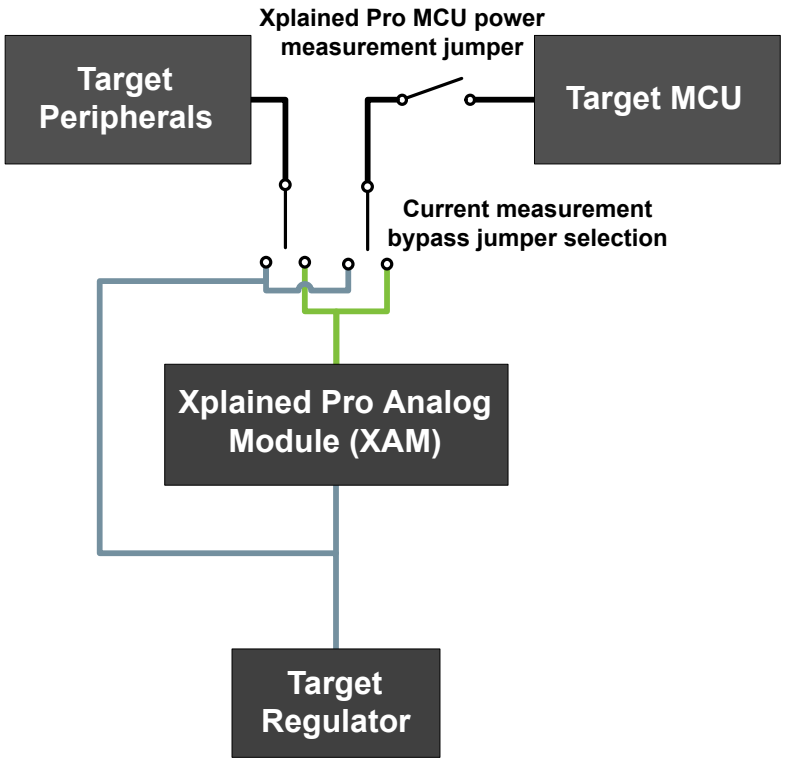
Table 4-23 GPIO Lines Connected to the EDBG

SAM L22 pin	Function	Shared functionality
PB04	GPIO0	SLCD and EXT2
PB05	GPIO1	SLCD and EXT2
PB06	GPIO2	Shield and EXT2
PB07	GPIO3	Shield and EXT2

4.5. SAM L22 Xplained Pro XAM Configuration

On the SAM L22 Xplained Pro the MCU and the MCU peripherals (e.g. extensions) are powered by its own regulator as shown in Figure 4-3 SAM L22 Xplained Pro XAM Implementation Block Diagram on page 29. All other parts of the board, mainly embedded debugger and accompanying Xplained Pro Analog Module (XAM), are powered from a separate regulator. The current to the MCU and peripherals can be measured by connecting them to the XAM output through jumper settings.

Figure 4-3 SAM L22 Xplained Pro XAM Implementation Block Diagram



On the SAM L22 Xplained Pro the XAM can be used in four configurations:

1. **No current measurement or external MCU current measurement**: The XAM is bypassed and thus the MCU and peripherals are supplied directly by the regulator. Set both jumpers in the "BYPASS" position. In this configuration it is also possible to connect external measurement tools on the Xplained Pro MCU power measurement header to measure MCU current directly instead of using the XAM.
2. **MCU current measurement**: The XAM measures only the MCU current while the peripherals are supplied directly by the regulator. For this configurations place the jumper for "I/O" (peripherals) into the "BYPASS" position and the for "MCU" into the "MEASURE" position.
3. **Peripherals measurement**: The XAM measures only the peripherals current while the MCU is directly supplied by the regulator. For this configuration place the jumper for "MCU" into the "BYPASS" position and the "I/O" jumper into the "MEASURE" position.
4. **MCU and peripherals measurement**: In this configuration both MCU and peripherals are measured by the XAM. Place both jumpers on "I/O" and "MCU" headers in the "MEASURE" position.

4.6. Kit Modifications

SAM L22 Xplained Pro has several resistors that can be used to disconnect I/O pins of the ATSAML22N18A from connectors and on-board ICs and to disconnect power signals.

Info: Note that there are some resistors that aren't mounted by default on the kit listed in the table below.

Table 4-24 Zero Ohm Resistors

Designator	Value	From	To	Comment
J100	cut-strap	VCC_P3V3	VCC_P3V3_CM_IN	ATSAML22N18A, peripherals and connectors power supply
R107	0R	U100 OUT	VCC_CM_P3V3	XAM power supply
R108	0R	U100 OUT	VCC_EDBG_P3V3	EDBG power supply
R301	0R	U302 AUTHO	PC21 GPIO	Allows complete or partial disconnect of U302, ATAES132A fom ATSAML22N18A
R305	0R	U302 SDA	PB30 I2C SDA	
R307	0R	U302 SCL	PB31 I2C SCL	
R400	39R	EDBG TARGET RESET	TARGET MCU RESET	Debug interface from the EDBG to the ATSAML22N18A
R404	0R	EDBG SWCLK	PA30 SWCLK	
R405	0R	EDBG SWDIO	PA31 SWDIO	
R406	0R	EDBG CDC RX	PC24 UART TX	EDBG CDC and DGI interfaces to the ATSAML22N18A
R407	0R	EDBG I2C SDA	PB30 I2C SDA	
R408	0R	EDBG I2C SCL	PB31 I2C SCL	
R414	330R	EDBG CDC TX	PC25 UART RX	
R415	0R	EDBG SPI MOSI	PB22 SPI MOSI	
R416	330R	EDBG DGI_GPIO0	PB04 GPIO	
R417	330R	EDBG DGI_GPIO1	PB05 GPIO	
R418	330R	EDBG DGI_GPIO2	PB06 GPIO	
R419	330R	EDBG DGI_GPIO3	PB07 GPIO	
R420	330R	EDBG SPI MISO	PB24 SPI MISO	
R425	0R	EDBG SPI SCK	PB23 SPI SCK	
R426	0R	EDBG SS	PB25 SPI SS	
R427	0R	TARGET RESET SENSE	TARGET_MCU_RESET	Reset sense signal to EDBG, used to detect external resets
R900	0R	TARGET MCU RESET	RESET UNO	ATSAML22N18A reset signal to Arduino connectors

Figure 4-4 Assembly Drawing Top

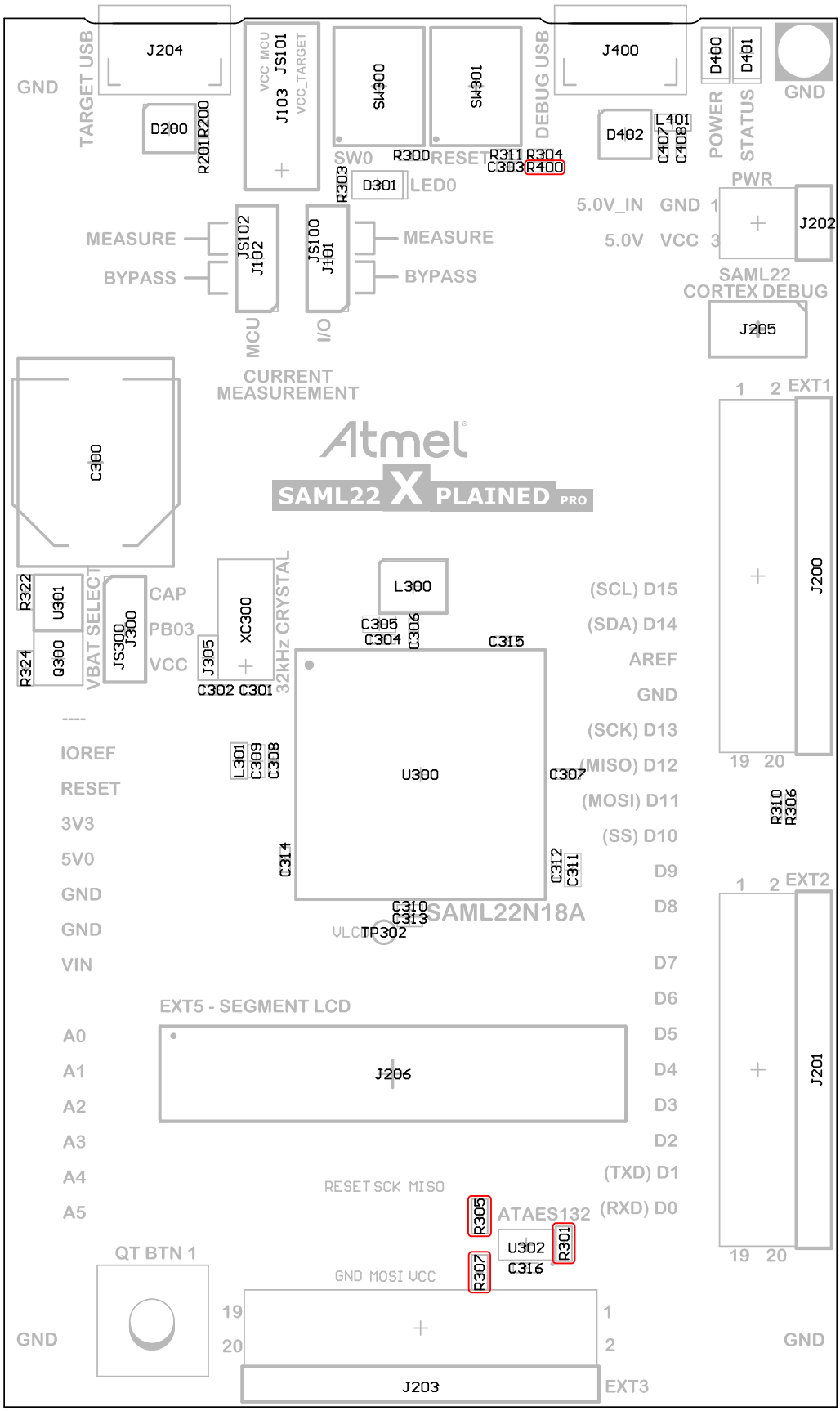
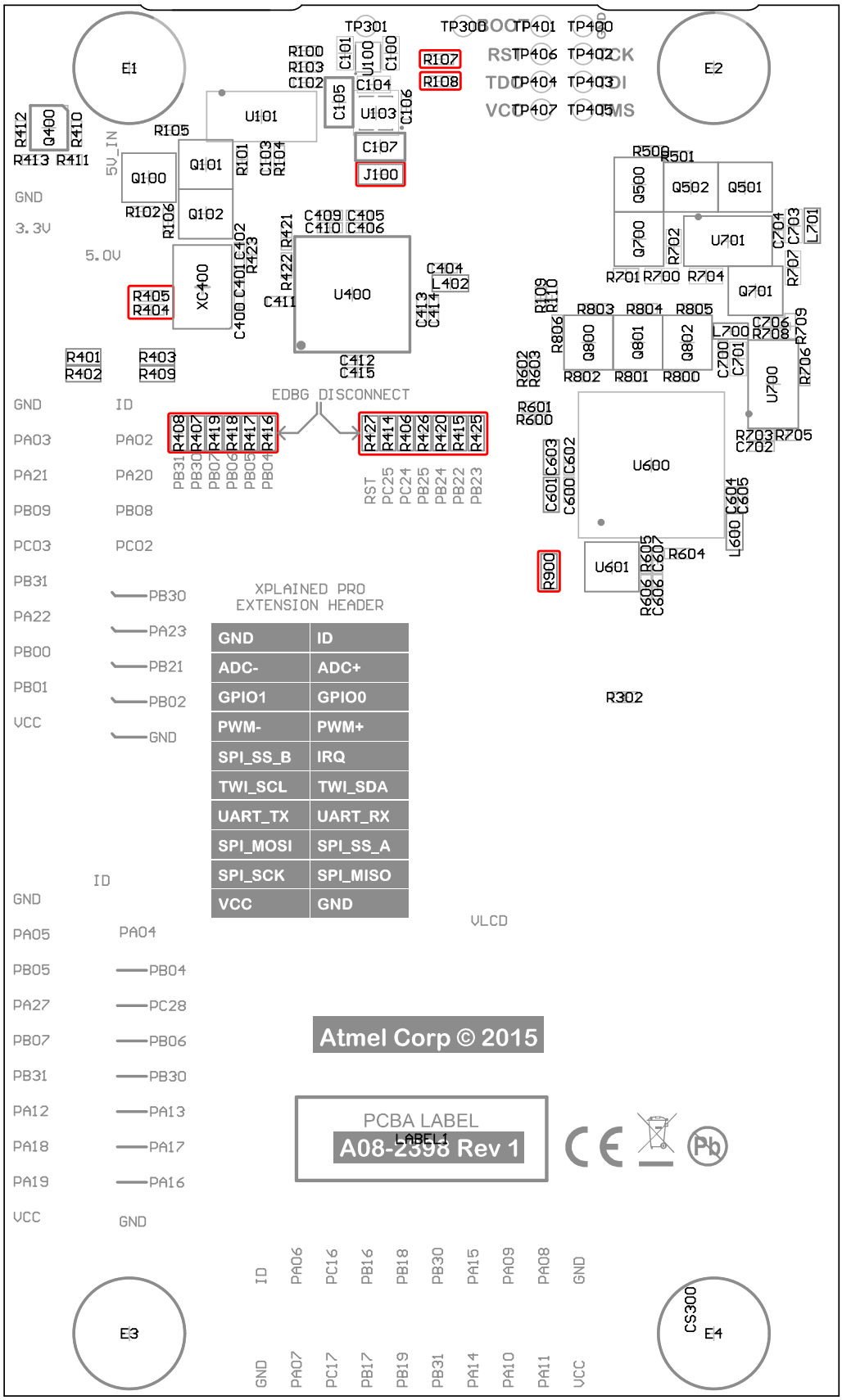


Figure 4-5 Assembly Drawing Bottom



GND	ID
ADC-	ADC+
GPIO1	GPIO0
PWM-	PWM+
SPI_SS_B	IRQ
TWI_SCL	TWI_SDA
UART_TX	UART_RX
SPI_MOSI	SPI_SS_A
SPI_SCK	SPI_MISO
VCC	GND

4.6.1. Operation at Other Voltages

The SAM L22 Xplained Pro board is operated at 3.3V by default, but it also has the possibility of running at lower voltages from an external supply. The EDBG is designed to run from a 3.3V supply and won't work on other voltages, therefore all connections from the EDBG and the on board 3.3V regulator to the ATSAML22N18A has to be removed.

To completely disconnect the EDBG and the on-board power supply from the ATSAML22N18A do the following:

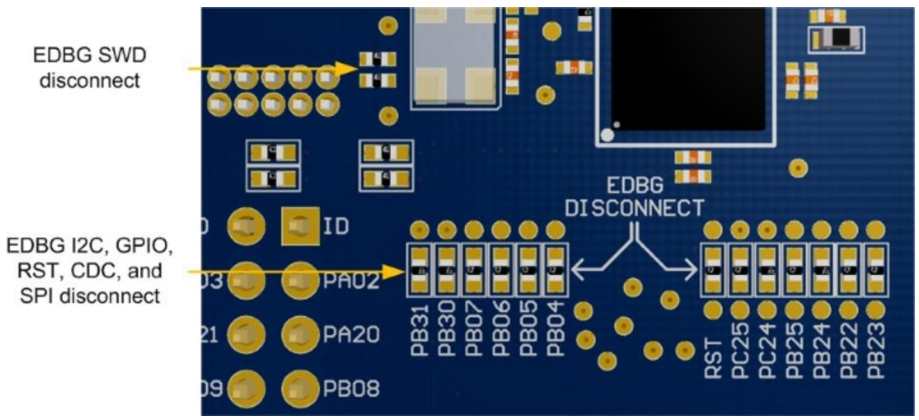
- Cut J100
- Remove R400, R404, R405, R406, R407, R408, R414, R415, R416, R417, R418, R419, R420, R425, R426, R427

Figure 4-6 SAM L22 Xplained Pro EDBG disconnect on page 33 shows all components that have to be removed from the bottom side of the PCB for operation at other voltages, to locate the other components see the assembly drawing in the section above. When the components are removed, the kit can be supplied with a desired voltage through the pins marked 3V3 (pin four) and GND (pin two) on the Xplained Pro power header. To program and debug the ATSAML22N18A the 2x5 50mil cortex debug connector has to be used with an external debugger.

Info: Operating the ATSAML22N18A on other voltages than 3.3V requires physical modifications on the kit using a soldering iron and an external debugger for programming the ATSAML22N18A. The on-board current measurement only works at 3.3V. The on board LED is selected for 3.3V operation, the light level at 1.8V opeartion is very low. To increase the emitted light level the value of the series resistor can be lowered. The EDBG functionality can be restored by re-soldering the removed components and soldering a 0-ohm resistor over J100.

Caution: The voltage supplied through the power header is applied directly to the ATSAML22N18A and the extension headers, applying a voltage greater than 3.3V may damage the board permanently.

Figure 4-6 SAM L22 Xplained Pro EDBG disconnect



Related Links

Xplained Pro Power Header on page 14

Cortex Debug Connector on page 24

Connectors on page 15

5. Hardware Revision History and Known Issues

5.1. Identifying Product ID and Revision

The revision and product indentifier of Xplained Pro boards can be found in two ways; either through Atmel Studio or by looking at the sticker on the bottom side of the PCB.

By connecting an Xplained Pro MCU board to a computer with Atmel Studio running, an information window will pop up. The first six digits of the serial number, which is listed under kit details, contain the product identifier and revision. Information about connected Xplained Pro extension boards will also appear in the Atmel Kit's window.

The same information can be found on the sticker on the bottom side of the PCB. Most kits will print the identifier and revision in plain text as A09-nnnn\rr, where nnnn is the identifier and rr is the revision. Boards with limited space have a sticker with only a QR-code, which contains a serial number string.

The serial number string has the following format:

"nnnnrrssssssssss"

n = product identifier

r = revision

s = serial number

The product indentifier for SAM L22 Xplained Pro is A09-2547.

5.2. Revision 2

Revision 2 is the initially released revision.

Segment LCD1 Xplained Pro (ATSLCD1-XPRO) is bundled and shipped together with revision 2 of SAM L22 Xplained Pro.

6. Appendix

6.1. Getting Started with IAR

IAR Embedded Workbench® for ARM® is a propriatory high efficiency compiler not based on GCC. Programming and debugging of Xplained Pro kits are supported in IAR™ Embedded Workbench for ARM using the common CMSIS-DAP interface. Some intial settings have to be set up in the project to get the programming and debugging to work.

The following steps will explain how to get your project ready for programming and debugging:

1. Make sure you have opened the project you want to configure. Open the **OPTIONS** dialog for the project.
2. In the category **General Options**, select the **Target** tab. Select the device for the project or, if not listed, the core of the device.
3. In the category **Debugger**, select the **Setup** tab. Select **CMSIS DAP** as the driver.
4. In the category **Debugger**, select the **Download** tab. Check the checkbox for **Use flash loader(s)** option.
5. In the category **Debugger** > **CMSIS DAP**, select the **Setup** tab. Select **System (default)** as the reset method.
6. In the category **Debugger** > **CMSIS DAP**, select the **JTAG/SWD** tab. Select **SWD** as the interface and optionally select the **SWD speed**.

Figure 6-1 Select target device

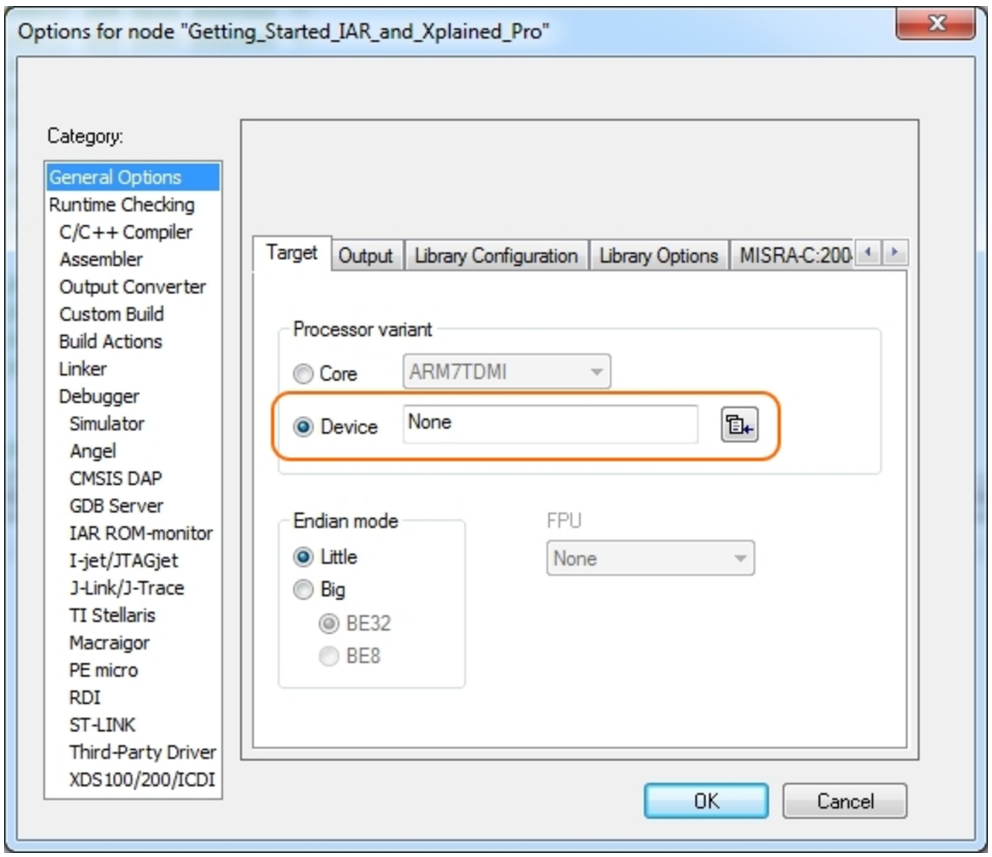


Figure 6-2 Select debugger

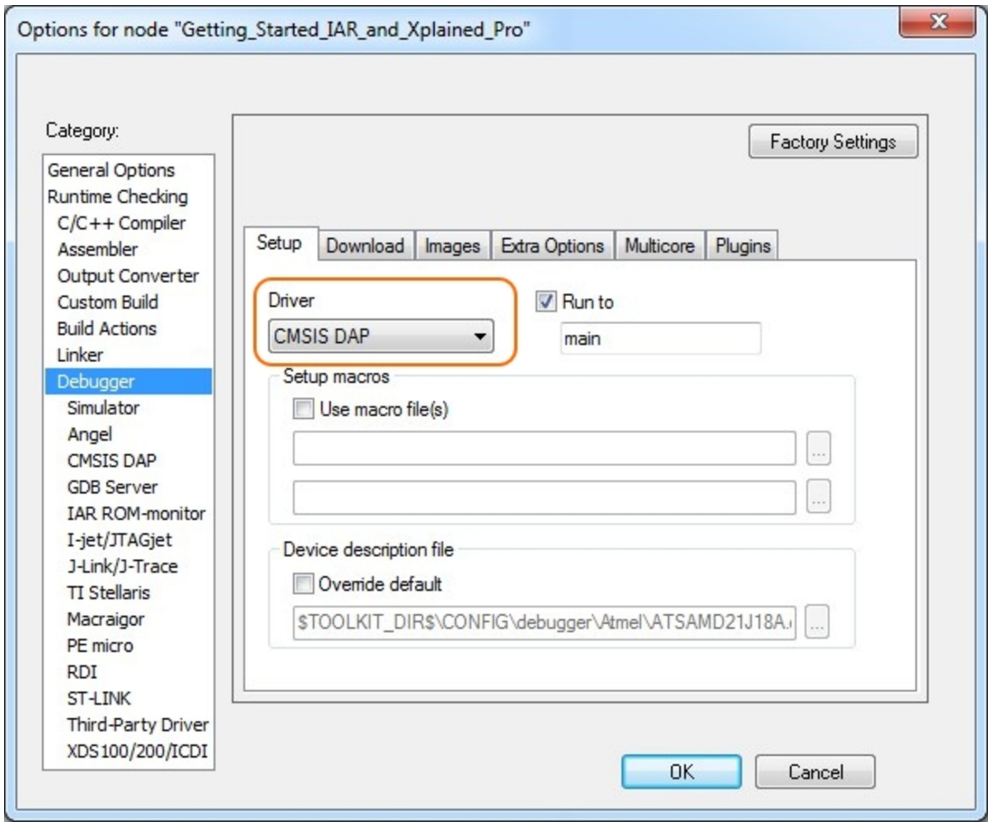


Figure 6-3 Configure flash loader

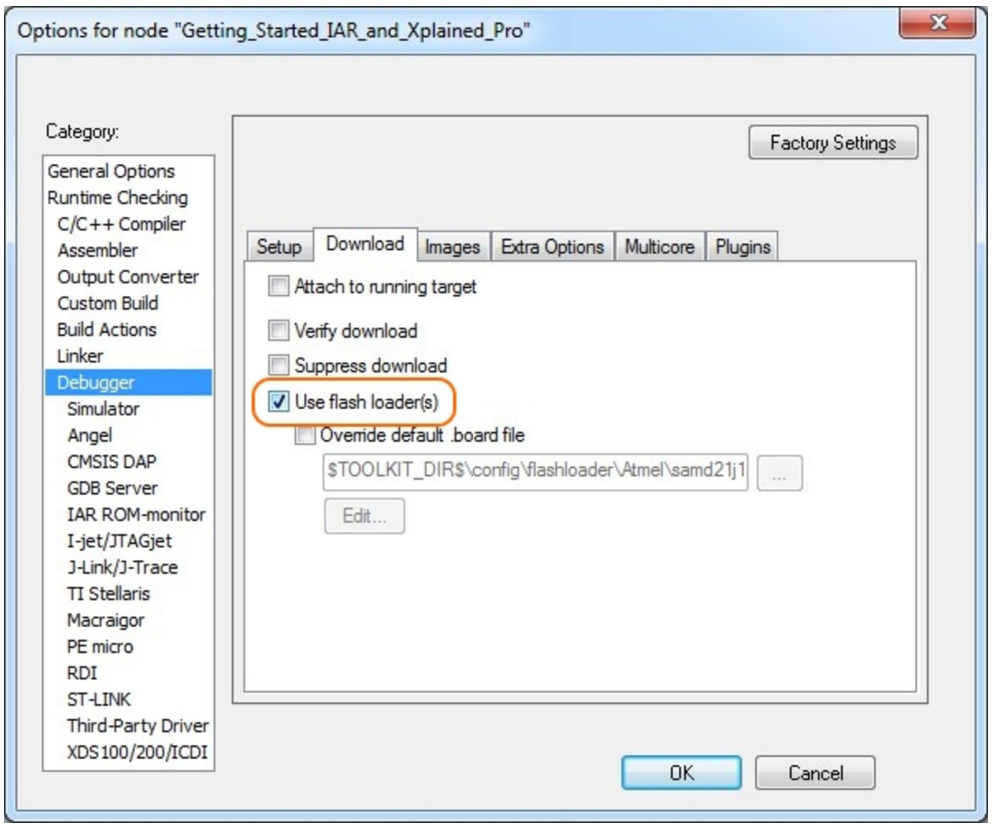


Figure 6-4 Configure reset

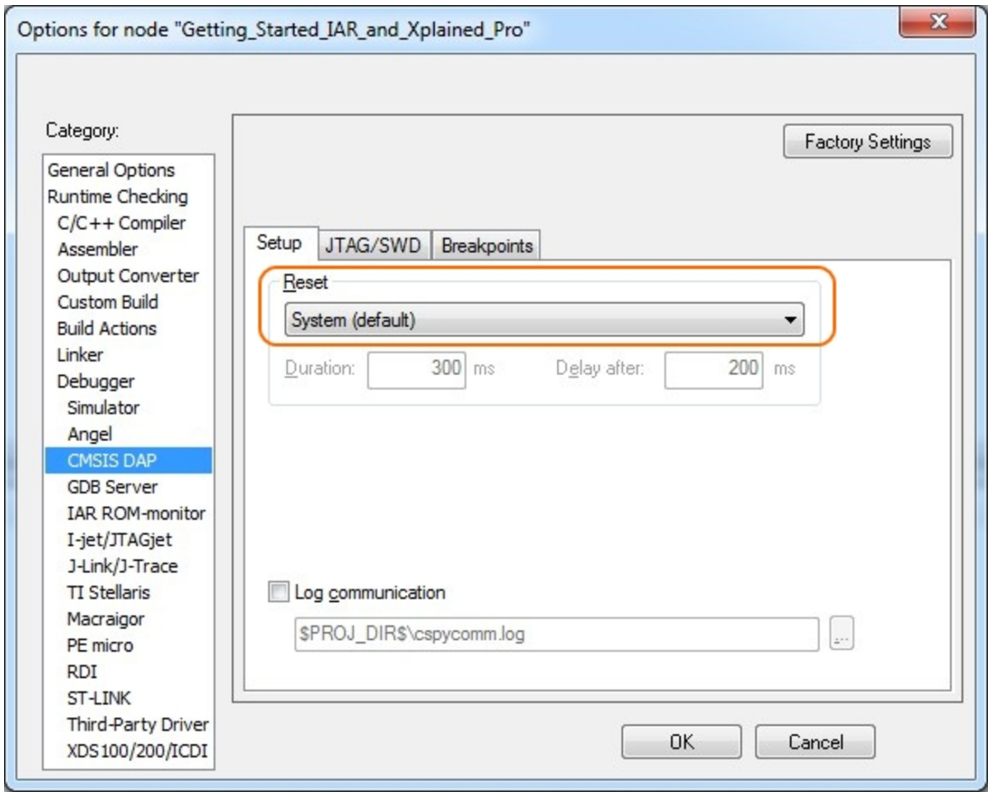
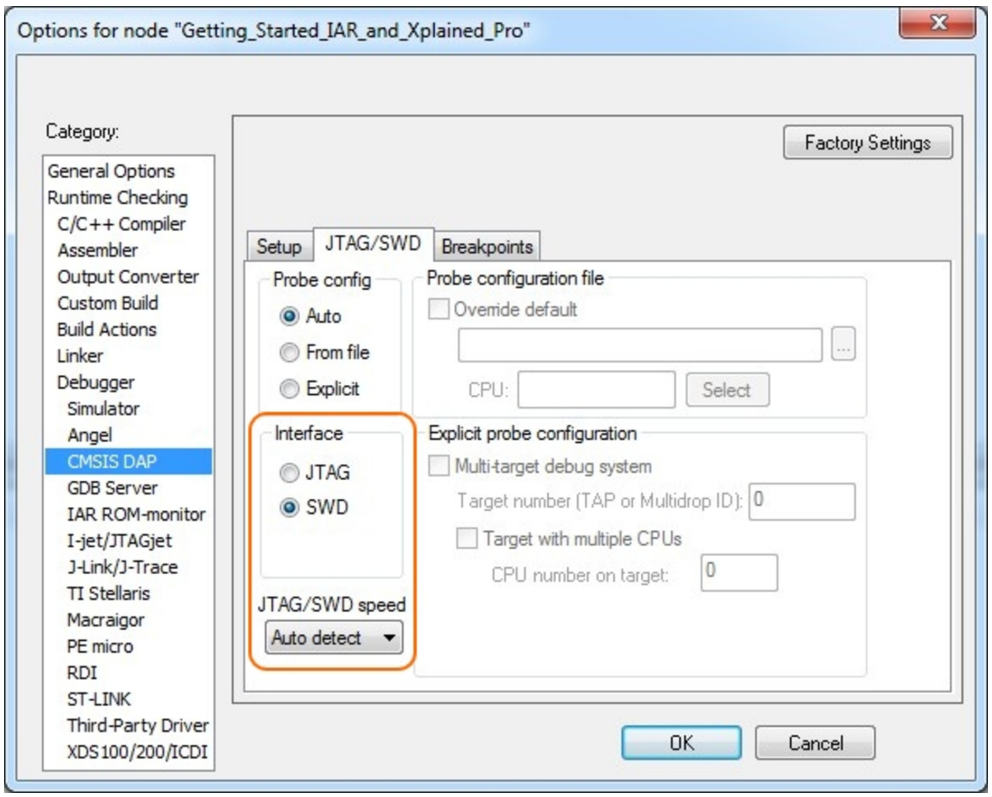


Figure 6-5 Configure interface



7. Document Revision History

Doc. rev.	Date	Comment
42474A	08/2015	Initial document release.

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